PROJECT
facts

U.S. DEPARTMENT OF ENERGY
OFFICE OF FOSSIL ENERGY
NATIONAL ENERGY TECHNOLOGY LABORATORY

Petroleum Exploration and Production

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WELL INTEGRITY MODELING FOR DEEPWATER GULF OF MEXICO SUBSALT OIL FIELDS

PARTNERS

Sandia National Laboratory
Albuquerque, NM
BHP Billiton
Houston, TX
BP America
Houston, TX
ChevronTexaco
San Francisco, CA
ConocoPhillips
Houston, TX
ExxonMobil
Houston, TX
Halliburton
Dallas, TX
Kerr-McGee
Houston, TX
Shell E&P
Houston, TX
Petrobras SA
Rio de Janeiro, Brazil

MAIN SITE

Sandia National Laboratory
Albuquerque, NM

Background

The deepwater Gulf of Mexico (GoM) is the most active deepwater region in the world and provides some of the greatest challenges in scope and opportunity for the petroleum industry. The region is estimated to contain undiscovered recoverable resources of nearly 30 billion barrels of oil. By 2005, as much as 67 percent of the daily oil production and 26 percent of the daily gas production in the gulf will come from deepwater fields. Huge formations of salt, thousands of feet thick, underlie much of the deepwater – and these salt formations deform plastically and behave differently from sands and shales familiar to the industry. Complex salt movement coupled with the extreme water (up to 10,000 ft) and reservoir depths necessitate high development costs, and innovative technology is required to bring these fields on stream. Difficulties, such as collapsing a well during drilling, can be encountered near salt formations, because of the changing stresses associated with salt deformation. Also, after a well penetrating a salt formation is cased and completed, the slow movement of salt over the field lifetime may cause premature failure of the casing through shear and twisting.

Project Description/Accomplishments

Salt movement can cause failure in well casings drilled either through or just next to salt diapirs (salt diapirs are bodies of salt that move upward due to buoyancy forces, causing deformation). Sandia conducted a study that assessed the timing and magnitude of salt forces on well casings, including the behavior of reservoir rocks during oil production, and on in situ stresses in formations adjacent to massive salt diapirs. Laboratory experiments were conducted to constrain the behavior of deepwater GoM salts, and to compare their behavior with that of salts encountered during oil and gas exploration and production in the U.S. Western Overthrust belt and in the North Sea. Computer models were developed to understand and predict the complex geomechanical behavior of subsurface formations and to identify optimal well paths and locations of potential borehole instability. Forces on well casings over the field lifetime were identified resulting in modification of well construction design. Examination of the role of cement between casing and wellbore resulted in recommendations on when and how cement should be used to alleviate casing stresses that could lead to failure. The project is designed as a Joint Industry Project (JIP) with co-funding by the DOE and an industry consortium.

Benefits/Impacts

The improved wellpath and casing design has been applied in two of the five largest oil fields ever discovered in the deepwater GoM - the Thunder Horse North and Mad Dog fields operated by BP America with multiple partners. The more efficient well casing design implemented in the Thunder Horse North field resulted in well construction cost reduction of over $30 million dollars. Applied to other potential wells in the Gulf of Mexico, the improved understanding of well casing design is expected to significantly reduce drilling and completion costs.

Integral to the successful economic development of the deepwater Gulf of Mexico, where the cost for drilling and completing a single well can be $50-$100 million, is that the lifetime of a well spans 10-20 years. The project focuses on identifying, quantifying, and mitigating potential well integrity issues specific to subsalt and near-salt deepwater reservoirs. The research shows how to more accurately plan subsalt wells that penetrate massive salt diapirs, and how to design robust well casings to resist salt movement. The project is ongoing, and related work is also conducted through additional proprietary partner-funded projects as well as industry training.

The research has enabled development of a more efficient casing design for oil and gas well construction in the Gulf of Mexico. Such innovative technology will help to produce the estimated 28.8 billion barrels of recoverable reserves.

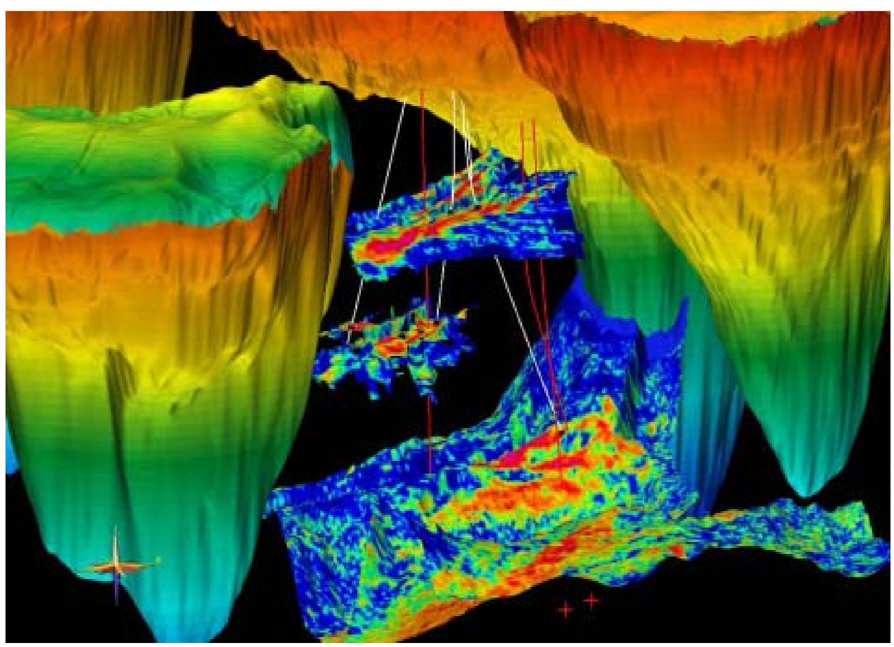

Photo credit: BP America

3-D visualization of salt diapirs ("tooth shaped" features) adjacent to stacked series of oil-saturated reservoirs sands in the deepwater GoM. The reservoirs adjacent to the salt diapir (right) have been dragged upwards as the salt diapir has risen.

CONTACTS

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PROJECT DATA

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Total Project Value
$1,765,000

DOE/Non-DOE Share
$590,000/$1,175,000

CUSTOMER SERVICE

1-800-553-7681

WEBSITE

www.netl.doe.gov